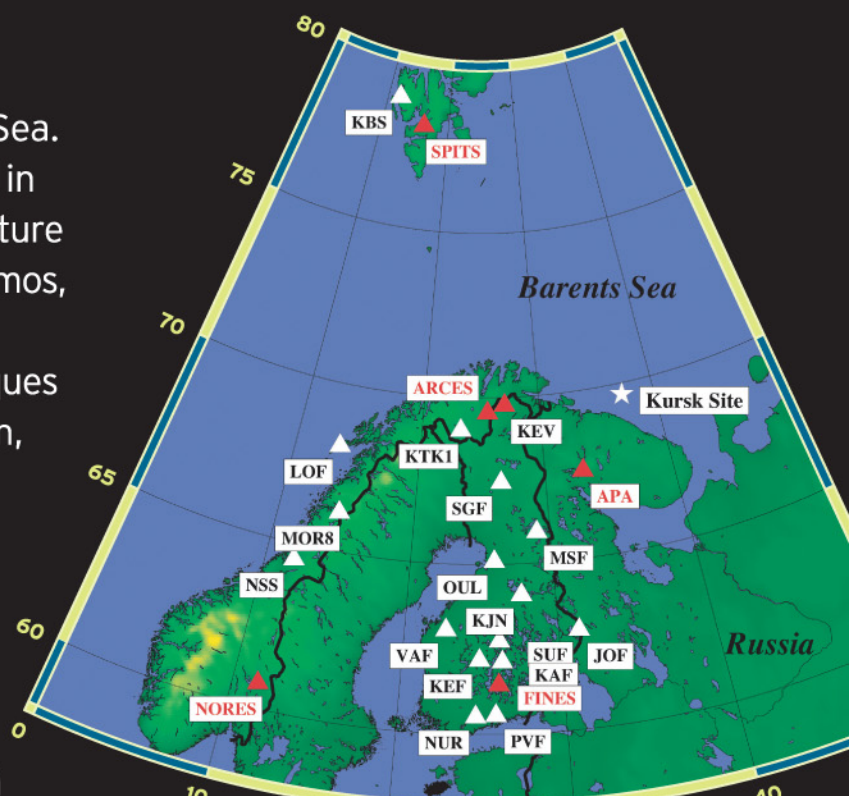
FORENSIC SLEUTHS RIDE THE WAVES

Fingerprinting Mystery Explosions

On August 12, 2000, the most advanced attack submarine in the Russian fleet sank in the Barents Sea. Details of what caused this accident were shrouded in secrecy and propaganda. To get a more accurate picture of the Kursk event, expert seismologists from Los Alamos, Southern Arizona Seismological Observatory, and Quantum Technology Services, Inc., used the techniques of forensic seismology to "fingerprint" the explosion, deduce its chronology, and determine its possible cause. Forensic seismology is significant because it provides tools to understand and detect such earth-shaking events as earthquakes, volcanic eruptions, and nuclear explosions.



"Little Ears" Hear the Explosion

Many seismic stations in the region recorded the Kursk event. The team used data from the stations marked with a red triangle.

Explosions are heard around the region

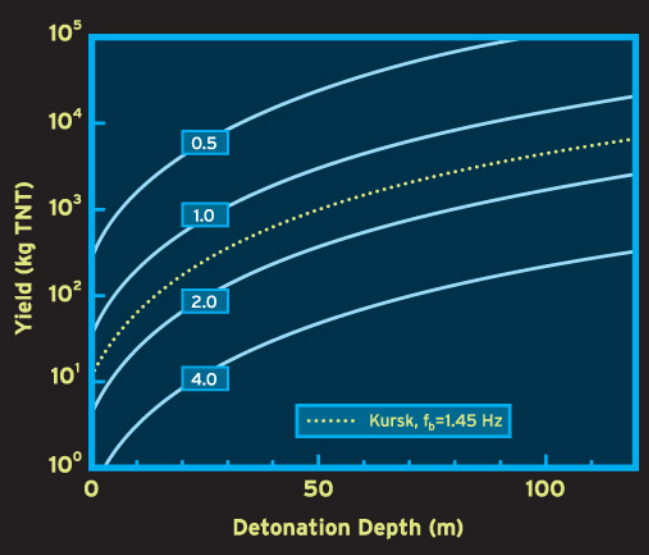
The team retrieved key data from several seismic monitoring stations in the region. Since the 1950s, a worldwide network of seismic monitoring stations has been deployed, spurred by the international need to monitor for underground nuclear tests. Stations more than 5,000 kilometers from the Barents Sea recorded the main Kursk event.

Waveforms provide context for the events

To find repeated wave shapes, the team applied waveform correlation detection techniques to the retrieved seismic data. The analysis revealed that there were two key, repeated waveforms indicating two key explosive events. The first occurred 135 seconds before the larger explosion. The similarity between the two key waveforms indicates that the two events were located at the same point and were caused by similar source mechanisms.

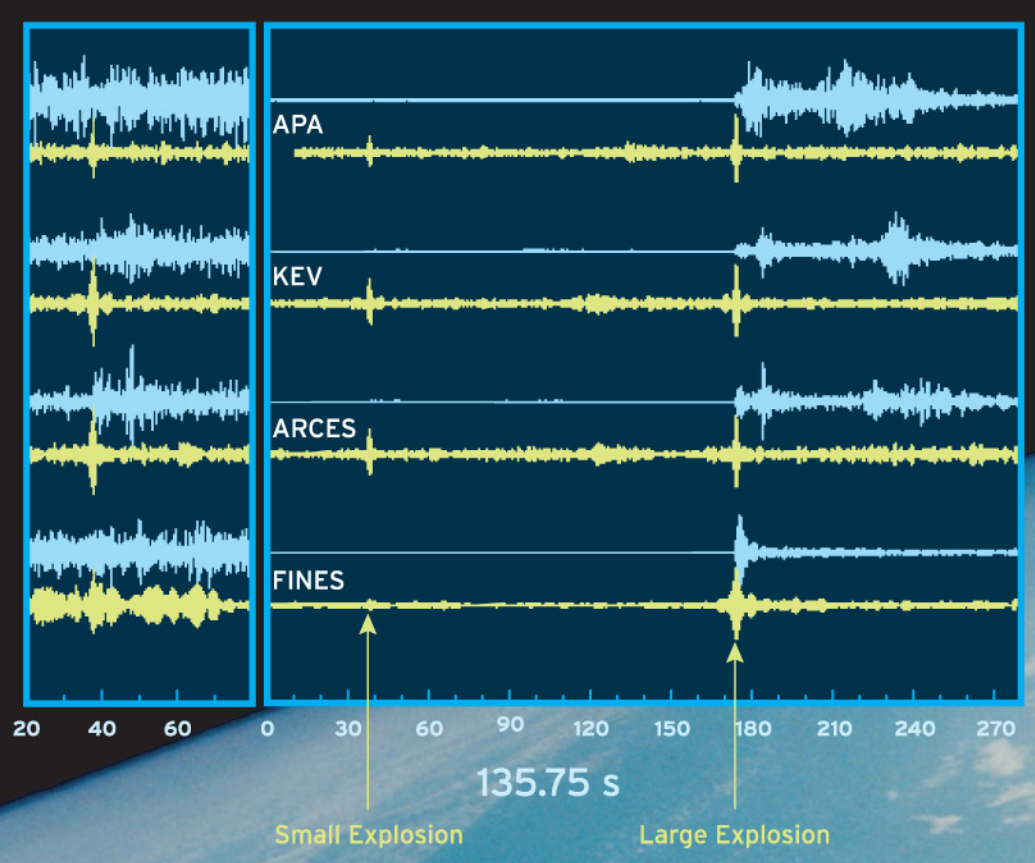
Analysis reveals explosive yield

To infer the nature and yield of the Kursk events, the team next looked for bubble pulse oscillations in the waveforms. Because a bubble pulse was clearly observed, the team deduced that the main event was the direct result of an explosion, not a collision. The main event released energy equivalent to 3.7×10^3 kilograms of TNT explosive. Most likely, the precursory event was a disabling explosion that directly or indirectly led to the catastrophic explosion 135 seconds later.



Sizing up the Explosion

The dominant bubble-pulse frequency, f_b, of an underwater explosion largely depends on explosive yield and detonation depth. The frequency spectrum peak caused by the reverberation fixes the depth at 80 to 100 meters. The team observed an f_b of 1.45 hertz (see dotted line on the graph) for the main Kursk event and thus estimated the explosive yield to have been the equivalent of 3,000 to 4,500 kilograms of TNT.



Catching a Wave

The team applied waveform correlation detection to "fingerprint" the explosion. A small, precursory explosion had a waveform identical in shape to that of the main explosion, which occurred 135.75 seconds later. That identical shape indicates that the two events happened at the same location and had similar source mechanisms.

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